There is a suggestive paper by Dr. Mackie, of Elgin, on "The Felspars present in Sedimentary Rocks as Indicators of the Conditions of Contemporaneous Climate."

MESSRS. J. J. GRIFFIN AND SONS, LTD., have issued a new edition of their illustrated catalogue of chemical apparatus and reagents published under the title "Chemical Handicraft." Hints on manipulation of instruments and arrangement of apparatus are occasionally given, and they assist in making the volume a useful catalogue for chemical laboratories and technical schools.

NEW and revised editions have been received of several well-known scientific books. The fourth edition of Prof. Grenville Cole's "Aids to Practical Geology" has been published by Messrs. C. Griffin and Co. The book is the most helpful guide which the student who desires to become intimately acquainted with the characters of rocks and minerals could possess. It is not intended to take the place of a field geology, but to show how every specimen obtained may be minutely examined in the laboratory or study, and its place among rocks or fossils understood. Work of this kind is practical geology in as scientific a sense as observations in the field.—Messrs. Cassell and Co. have published a popular edition of Mr. Richard Kearton's interesting book "With Nature and a Camera." The 180 pictures reproduced from photographs by Mr. Cherry Kearton have given pleasure to many outdoor naturalists.—The valuable text-book of "Agricultural Botany," by Prof. J. Percival, published by Messrs. Duckworth and Co. and reviewed in these columns in October, 1900 (vol. lxii. p. 570), has reached a second edition. It is satisfactory to know that students of agriculture are using a book in which plant structure and growth are dealt with scientifically.—The eighth edition of "Astronomy with an Opera Glass," by Mr. G. P. Serviss, has been published by Messrs. Hirschfeld Brothers, Ltd.—A new edition of Prof. J. G. Macgregor's "Elementary Treatise on Kinematics and Dynamics" has been published by Messrs. Macmillan and Co., Ltd. Few changes have been made, and the book retains its character as a comprehensive treatise in which the whole subject is treated systematically, without reference to the requirements of examining bodies.

THE additions to the Zoological Society's Gardens during the past week include a Dusty Ichneumon (*Herpestes pulverulentus*) from South Africa, presented by Capt. A. Perkins; two Larger Egyptian Gerbilles (*Gerbillus pyramidum*) from North Africa, presented by Col. Momber; a Buffon's Touracou (*Turacus buffoni*) from West Africa, presented by Capt. H. A. Thorne; two Long-tailed Whydah-birds (*Chera progne*) from South Africa, presented by the Rev. R. Armitage; a Richardson's Skua (*Stercorarius crepidatus*) European, presented by Lt.-Col. L. H. Irby; a Sykes's Monkey (*Cercopithecus albigularis*), a Grant's Gazelle (*Gazella granti*), a Banded Ichneumon (*Crossarchus fasciatus*), a Vulturine Guinea Fowl (*Acryllium vulturinum*), a Bateleur Eagle (*Helotarsus ecaudatus*), three White-winged Whydah-birds (*Urobrachya albonotata*) from East Africa, a Buffon's Touracou (*Turacus buffoni*), a Red-faced Weaver-bird (*Foudia erythrops*), seven Orange Weaver-birds (*Euplectes franciscana*), two Pintailed Whydah-birds (*Vidua principalis*), three Paradise Whydah-birds (*Vidua paradisea*) from West Africa, two Maguari Storks (*Dissura maguari*), two Snowy Egrets (*Ardea caudidissima*), four Black-pointed Teguexins (*Tupinambis nigropunctatus*), four South American Rat Snakes (*Spilotes pullatus*) from South America, two Brazilian Cariamas (*Cariama cristata*) from Brazil, deposited; a Black-winged Peafowl (*Pavo nigripennis*) from Cochin China, purchased; a Great Bird of Paradise (*Paradisea apoda*) from the Arrow Islands, received in exchange; a Brindled Gnu (*Connochaetes taurina*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE SUNSPOT CURVE AND EPOCHS.—The great importance of collecting as many facts as possible regarding solar activity, and revising them from time to time as new information is gathered, is clearly shown by the paramount *rôle* that the sun plays in causing the numerous variations in meteorological phenomena. Wolf's relative numbers have been, and are now, so commonly used when reference has to be made to solar activity that it is of the first importance that such a series of values should be as near correct as possible. It is with great satisfaction, therefore, that we note that Wolfer has so diligently continued the useful work, ably begun by Wolf, that he has now published (*Meteorologische Zeitschrift*, May, 1902) a new set of values carefully revised and brought up to date. As he remarks, an examination of the original manuscript at the observatory with various published tables has shown that a great number of differences and printer's errors have crept in, suggesting that it is time that a new edition was published. This reduction has been very carefully made by Wolfer and his assistant, each making the computations twice. In addition to the observed relative numbers, the paper gives smoothed relative numbers, while a third table shows the epochs of maxima and minima with their corresponding weights; the addition of the weights to the dates of these epochs is a very valuable piece of information which will add to the utility of the earlier epochs.

METHOD OF OBSERVING ALTITUDES AT SEA DURING NIGHT-TIME.—In a paper read before the Royal Dublin Society, Prof. Joly introduced recently a method for observing the altitude of a celestial body at sea which may prove extremely useful for taking bearings at night-time or when the horizon is obscured. Assuming that the vessel is provided with the usual Board of Trade rescue signals, one of these is perforated and dropped overboard. This will furnish a bright white light visible in clear weather up to five miles, and burning for about half an hour. To the signal is attached a suitable sinker, so that it will not drift appreciably. Selecting a star, the observer takes its bearing and then alters his course to the opposite bearing, thus bringing the star right astern. The signal is then dropped overboard, and at the same time a reading of the log is taken. After the vessel has travelled a distance of about a mile from the signal, as indicated by the log, the observer takes the angular elevation of the star over the signal, using the sextant in the usual manner. Corrections will have to be applied for the relative motion of the star from east to west at the rate of 1° in four minutes of time, for the larger angle of "dip," and also for the state of the water surface. In very rough water this last correction becomes of special importance, and formulæ with reduction tables are given to show the influence of waves of varying heights. The routine to be followed in observing two altitudes for a "Sumner" position is also described (*Scientific Proceedings* of the Royal Dublin Society, vol. ix., n.s., part v., No. 46, pp. 559–567).

LIQUID FUEL FOR STEAM PURPOSES.

THE possibility of burning a liquid fuel with very great advantage in most circumstances as compared with a solid fuel has been so long recognised that it is astonishing the practice has not been more generally adopted. The success which has been gained in the last few years, however, will undoubtedly lead to a greatly extended use in the near future.

Naturally the choice of a fuel for steam raising is not altogether dependent upon the evaporative efficiency and other advantages which a particular one may possess, but will, of course, be largely influenced by relative market prices, and this, no doubt, has had considerable influence against the adoption of liquid fuel on a large scale in this country. The fuel natural to the locality will always have great advantages over an imported fuel, and England, having such valuable coal supplies to hand, whilst on the other hand having no great natural sources of liquid fuel, gives preference to that material which renders it most independent of outside supplies. Although gas tar and oil gas refuse may be frequently employed in a very economical manner, yet there is little doubt that with a greatly extended use of liquid fuel the prices of suitable bye-products would be so enhanced that imported liquid fuel would remain practically in possession of the field.

For this reason engineers who have perfected the methods of

burning liquid fuel have always considered the possibility of its use becoming limited in certain circumstances, and all modern appliances are so constructed that with slight trouble coal alone may be used in them to the best advantage. One of the great claims to be considered in favour of liquid fuel is the ease with which the burners can be extinguished and a coal fire substituted, thus enabling consumers to take every advantage of fluctuations in the prices of both fuels. For marine purposes this is most desirable, since at many ports liquid fuel would be far more economical to ship for boiler use than a suitable steam coal, whilst a vessel trading from a port—such as Cardiff or Newport—would naturally replenish her bunkers with the steam coal at hand.

Any liquid hydrocarbon of sufficiently high flash point may be used as a liquid fuel; thus residues from many manufacturing processes may be utilised in an economical manner. Astatki, the residuum from petroleum distillation, has been extensively used in Eastern Europe, but tar oils and the oils from oil gas plant are frequently employed. These oils are especially suitable for locomotive work, since most large railways make oil gas in considerable quantities for lighting purposes, and, moreover, have exceptional facilities for transporting gas tar from small towns on their lines where it can be obtained at a reasonable cost. On the Great Eastern Railway this form of liquid fuel is largely employed. Crude petroleum, which has been treated to remove the more volatile constituents and so bring its flash point above the imposed limit for use as fuel, is now being imported into this country. The various methods of burning liquid fuel have been classified by Aydon as follows:—

(1) *Injection with compressed air* (W. Bridges Adams, 1863; Tarbutt, 1885.)

(2) *Percolation through a porous bed* (C. J. Richardson, 1864; Weir and Gray; St. Caire Deville), in which the liquid fuel percolates upwards through a porous bed, accompanied by heated air (and sometimes steam also).

(3) *Vaporisation* (Foote; Simm and Barff, 1865-67), the oil being vaporised from a small retort heated in the furnace, or in some cases (Dorsett, 1868-69; Eames, 1875) by a special external heater for the retort.

(4) *Steam spray injection* (Aydon, Wise and Field, 1865-67), in which the oil is sprayed into the combustion chamber by a jet of steam, whilst at the same time the burner is so constructed that air, heated if possible, is drawn in to supply the oxygen necessary for combustion.

Such a classification does not include burning in open troughs, a method first introduced by Wittenström about the year 1884, and which for many purposes in stationary boilers, furnaces, &c., has met with considerable success; or the more recent method of Korting, by direct injection of heated oil at considerable pressure.

Excepting in a few special cases, the steam spray injection method has been universally adopted. Various extravagant claims have been made for the chemical action of the steam, but it is not easy to see from a theoretical standpoint that it has any advantage over injection by compressed air. From a practical point of view, however, the steam spray is the more simple, since it dispenses with the auxiliary apparatus necessary for the supply of the air blast. On a locomotive, where economy of space is of importance and suitable water for the boilers is readily obtainable, steam spray injection is universal. For marine boilers the choice formerly lay between steam and air injection, each having certain advantages. Using steam injection, the auxiliary apparatus necessary for the air-blast is done away with, thus giving economy of space, whilst it has the disadvantage of requiring more condensed water from the evaporators to replace the steam used. On the other hand, the extra steam necessary for the air-blowers can be condensed and returned in the usual way to the feed water-pipe, but of necessity extra machinery has to be employed. With the introduction of the Korting system referred to above, and the success which has attended its use, notably on the Hamburg-American Line steamers, the marine engineer now has the choice of another method, and everything seems favourable to the extensive adoption of this new system in the future.

From the numerous estimations of the calorific value of different liquid fuels, we may approximately state that in centigrade units it has a value of 10,500, whilst for good steam coal a value of 8000 to 8500 may be taken. It will thus be seen that the liquid fuel has a decided advantage. The usual calculations of the theoretical heating value of a fuel fail to take one important factor into consideration, namely, the physical condition of the fuel. Thus the determined calorific value of carbon is always that of solid carbon, the value for hydrogen being obtained experimentally for hydrogen gas; but although in coal the carbon is in the solid form, it is certain that in liquid fuels it has undergone the first change in the passage of a solid to a gaseous condition, and consequently carbon in a liquid fuel will have a higher calorific value by just as much heat as would be required theoretically to raise solid carbon to the liquid condition. Aydon has estimated that this is equivalent to an expenditure of some 3500 calories.

It is, of course, impossible even with the most perfect appliances to obtain anything like the full heating effect of a fuel in any boiler, and the only real test of the value of competing fuels is their performance under similar conditions in practice. One is struck at the outset with the extremely contradictory figures which have been published to show the evaporative duty of liquid fuel, figures ranging from 46 lbs. of water per lb. of fuel burnt to 14 or 16 lbs. per lb. It may be taken, however, that in modern practice an efficiency of 15 lbs. by steam injection is a very fair result. Many comparisons have been made with coal in the same boilers and under the same conditions with results varying from 7 to $8\frac{1}{2}$ lbs. of water evaporated per lb. of coal consumed. A valuable series of tests made by the Engineers' Club of Philadelphia in 1892 gave the following results:—

1 lb. anthracite evaporated	9·7 lbs.	of water.
1 lb. bituminous coal	10·14 ,,	,,
1 lb. oil 36° B.	16 48 ,,	,,
1 cu. ft. of gas 20 C.P.	1·28 ,,	,,

We are indebted to the carefully recorded results obtained by Mr. Urquhart on the Grazi and Tzaritzin Railway for probably the best published figures of the relative merits of solid and liquid fuels. In winter he found that liquid fuel was 41 per cent. in weight and 55 per cent. in cost better than anthracite coal; or, compared with bituminous coal, 49 per cent. by weight and 61 per cent. in cost better. This was under the worst climatic conditions, and, as might be expected, in summer better results still were obtained. It must be borne in mind that these figures were deduced from the work of a large number of engines.

The Canadian Pacific Railway find that liquid fuel in use on their steamers effects a saving of 56 per cent. on the cost of coal firing.

In this country the pioneer of liquid fuel on our railways is Mr. James Holden and his company; the Great Eastern Railway has now more than sixty engines burning it, either alone or in conjunction with coal. In a note presented at the International Railway Congress in 1900, Mr. Holden gives the following particulars of express trains running between Liverpool Street and Cromer. The distance of 138 miles is covered in 175 minutes with a four minutes' stop, on a consumption of 14·4 lbs. of tar residues per train mile, and an equivalent of 5 lbs. per mile of coal, which is used in raising the steam necessary for starting the oil injectors. In the same paper it is stated that on railways working with wood fuel a saving of 50 per cent. has been effected by burning liquid fuel. Through the kindness of Mr. Holden, the writer recently made a long run on an engine burning crude coal tar over a coal fire with the Holden steam injectors, and was impressed with the ease of maintaining a regular steam pressure and the freedom from smoke.

The South Eastern and other railways are now fitting engines for this class of fuel, and an oil-fired engine is used for shunting on the Central London Railway. Boilers are also being fitted for liquid fuel at Woolwich Arsenal, and its use is extending amongst private firms.

In the English shipping trade the pioneers have been Messrs. Samuel and Co., the managers of the Shell Transport Company, and a reference to the excellent performance of their vessel the s.s. *Clam* will be found in a recent number of NATURE. An interesting account of the record voyage under liquid fuel appears in the *Shipping Gazette* of February 13, the vessel being the s.s. *Murex*, also belonging to the Shell Transport Company. This ship arrived at Thames Haven from Borneo *viâ* Singapore and the Cape on March 10, having steamed 11,830 miles on a consumption of 800 tons of prepared fuel.

The average daily consumption was from 17 to $18\frac{1}{2}$ tons, whilst the same vessel when under coal used from 24 to 25 tons.

The economy of cost in liquid fuel does not lie entirely in its superior evaporative value, for several other factors are all in its favour, and probably the greatest of these in the marine service is the reduction in the stokehold staff. Potter states that with fourteen tubular boilers (16 feet × 5 feet) twenty-five men were required for stoking with coal, but on the introduction of liquid fuel six men sufficed. On the s.s. *Murex*, referred to above, whilst more than twenty stokers were required when under coal fires, only three were carried to attend the oil burners. When the cost of wages, food, &c., for the large number of stokers carried on an average liner are taken into consideration, the possibilities for economy by the adoption of liquid fuel, when it can be obtained at a reasonable price, are very great. In the Royal Navy, where the stokers carried on a battleship run into big numbers, not only does liquid fuel tend to economy, but an even more important factor—the number of lives risked in an engagement—would be largely reduced. It is terrible to contemplate the fate of the engine-room staff in the event of one of our big ironclads being sunk by a torpedo or the ram of an adversary's ship.

For storage, liquid fuel has a slight advantage over coal. In general terms it may be said that one ton of liquid fuel will require 36 cubic feet of storage and steam coal from 43 to 45 cubic feet; but it must be remembered that coal bunkers have of necessity to be specially arranged for the easy delivery of the fuel at the stokehold level, whereas liquid fuel may be carried in places where the storage of a solid fuel is quite out of the question. By the adoption of some system of removing water from the oil, such as that of Flannery and Boyd, where two settling tanks are alternately employed, liquid fuel may be stored in water-ballast tanks and the fore and aft peaks of the vessel. Remembering that one ton of oil fuel has such a much larger evaporative efficiency than the same weight of coal, and, further, has advantages in storage, a very much larger cargo space can be reserved in a vessel, or in the case of the belligerent marine, with no greater total weight of fuel on board, a very greatly extended radius of action can be obtained.

A point in connection with coal as a fuel in steamships which is often overlooked is the large amount of inert material which must necessarily be carried in the bunkers; for example, a ship takes into her bunkers 2000 tons of steam coal (H.M.S. *Queen*, which was recently launched, has a coal capacity of 2040 tons), and taking a fair estimate of the ash of this coal at 5 per cent., it means finding space for at least one hundred tons of non-usable mineral matter, even assuming that the ash and clinker do not exceed the ash of the coal. In the case of liquid fuel, the whole amount stored is actually available as fuel, and there is no trouble with ash or clinker in the furnaces, or solid waste of any description to be got rid of.

On any vessel, and especially on a ship carrying passengers, the operation of coaling is a particularly disagreeable one. With liquid fuel there is really no inconvenience, for the oil can be pumped into the tanks in much less time than coal shipment takes, and, further, all the dirt associated with "bunkering" is avoided. At the present time it is well known that the Admiralty is carrying out experiments in coaling war vessels at sea, the collier being made fast astern and the coal hauled along a suitable transport arrangement. It would undoubtedly be a much simpler operation to transfer liquid fuel through a flexible hose of slightly greater length than the cables made fast between the two vessels, providing that an oil of reasonable viscosity was employed.

Even in a country possessing such splendid supplies of steam coal as England, liquid fuel is now making rapid headway, and this is not surprising when one considers the high prices reached for coal of all descriptions during the last two or three years. To be able to fall back on liquid fuel, when it can be obtained at a reasonable price, places the consumer in an independent position as regards the colliery proprietor, and the necessary fittings to enable this to be done are by no means costly. Coal at a fair price will probably always have the advantage over imported liquid fuel, but in countries entirely dependent upon imported fuel, the liquid form must in the future be the main upply, for bulk for bulk it is twice as efficient as any solid fuel, nd, moreover, its transport in suitable vessels is attended with far less risk than with coal cargoes shipped from a great distance.

J. S. S. BRAME.

THE MURCHISON FALLS.

THE new Government road from the capital of Uganda to Butiaba on the Albert Nyanza will shortly cause the existing caravan track, which crosses the Nile at Fajao, to be abandoned. The latter place obtained some notoriety during the Uganda mutiny 1897–8, but, not being exactly a health resort, the station was soon after given up, and a few Sudanese of the Uganda Rifles now guard the ferry.

On an isolated mass of rock overlooking the Nile, the European quarters are (or were when I passed through on my way from East Africa to the Sudan in October last) still marked by a couple of thatched huts in dilapidated condition, a flower-garden, and a flag-staff from which fluttered the remains of a "Union Jack." From the station a beautiful view of the Murchison Falls, about a mile distant, can be obtained.

Close to the station are two more isolated masses of biotite gneiss, and undoubtedly the river, which is here confined in a deep cañon, has carved its way eastward for one-and-a-half miles to the present falls, leaving these masses as "witnesses."

On arrival, I was struck by the peculiarly irregular sound of the falls; at night it is especially noticeable.

The track to the falls, used by native fishers, at the foot of the cliffs on the south side, follows close to the water's edge, and the sight of five crocodiles with wide-opened mouths on the opposite shore suggested unpleasant possibilities. Usually crocodiles can be seen in hundreds.

Scrambling along the slippery track, much overgrown in places, and glittering with disintegrated mica flakes, we passed several naked Wanyoro fishers in their canoes, and the decaying remains of fish, chiefly a species of perch, showed their favourite landing places.

Arriving at the 200-foot basin into which the fall takes its final plunge, one notices how the constant spray from the falls, ascending in clouds like steam, allows the luxuriant vegetation to grow over even the vertical cliffs surrounding the basin on three sides, except where the soft mica schist has caved in by weathering. A double rainbow added to the beauty of the scene, but the near view of the falls is distinctly disappointing.

The peculiar intermittent roar could now be accounted for; a mass of water tumbling headlong into the pool is immediately followed by an enormous broken wave, then comes a lull, and the process is repeated.

As this phenomenon was inexplicable from below, I suggested that a climb to the top of the falls was advisable; and after much discussion our Nubi guide extracted from an airily clad Mnyoro the information that a track did exist to the top of the south cliff. It proved to be a most trying 200-foot climb up a steep slope covered with dense grass, and it could only have been made by an energetic European. A short downward scramble led to a rock plateau with potholes, the largest of which was 15 feet in diameter and 10 feet deep, filled with water, marking the level of the former bed of the river when it swirled round a mass of gneiss in its centre. This being gradually worn away on the south side, apparently exposed a softer vein, and the river has cut its way through, in a deep vertical cleft from 20 to 30 feet wide and of unknown depth. A well-known officer in the Uganda Rifles whom I met two days later informed me that he had measured the narrowest portion accessible and found it only 18 feet wide.

Now the Nile above this is a succession of falls, and, after a sharp bend to the north-west, turns again west when 200 feet wide and, gradually narrowing, tumbles 10 feet over a rock ridge spanning the river and then over a 5-foot ridge. For 50 feet it rushes with increasing velocity and finally enters the extraordinary cleft. Down this, for 150 feet, the river "slithers," a solid mass of water, as if through a sluice. Suddenly it meets with an obstruction, a harder layer of gneiss through which it is undercutting its way, and with terrific force strikes this, and rebounds, sometimes with a huge shower of spray. Meanwhile the body of water behind has to find an outlet, and, still confined between high walls, is forced over the ridge with irresistible force ere, 250 feet further on, it tumbles over the last fall into the large basin below, and the back wave, now a vast boiling mass, follows hard after it. This explains the peculiar sound of this fall.

The pent-up power of the Nile as it leaps the barrier is extremely impressive, but from an engineering point of view it is regrettable that such enormous power is running to waste.

I returned to Fajao at sunset, in time to see the Nile tinged a